***Original Research Article***

**Diversity and Distribution of OrthopteranSpecies in Kalahandi District, Odisha: A comprehensive survey**

**Abstract**

Orthoptera species play crucial roles in food webs and are considered excellent bioindicators of environmental change due to their sensitivity to habitat alteration, climate variability, and land-use patterns. Indian orthopteran diversity is often studied in the context of agricultural entomology, as many species are known to damage important crops such as rice, wheat, maize, and sugarcane. Understanding orthopteran diversity in such lesser-known regions is not only important for biodiversity records but also essential for sustainable agricultural practices and ecosystem management. Orthopteran species were collected from different selected sites in Kalahandi district using an insect-collecting net and the hand-picking method between June 2024 and February 2025. A total of 8,724 individual orthopterans were captured and identified, representing five different families. The family Acrididae had the highest species diversity, comprising 19 species across 15 genera. This group was followed by the family Pyrgomorphidae, which included 7 species under 4 genera. The family Tettigoniidae consisted of 5 species across 4 genera. The lowest species diversity was recorded in the family Tetrigidae, with only a single species identified. The Simpson’s Index of Diversity (1-D) was 0.961, suggesting high species diversity within the community. Additionally, Shannon’s Diversity Index (H) was 3.341, and Pielou’s Evenness Index (J) was 0.964, both reflecting a high level of species richness and an even distribution of individuals among species.

**Key Words:** Orthoptera, Diversity, Kalahandi, Odisha

**1. Introduction**

Grasshoppers (Order: Orthoptera; Suborder: Caelifera) are among the most widespread and ecologically significant herbivorous insects found across terrestrial ecosystems. They play crucial roles in food webs and are considered excellent bioindicators of environmental change due to their sensitivity to habitat alteration, climate variability, and land-use patterns (Latchininsky et al., 2011; Fartmann et al., 2012; Chowdhury et al., 2023). Some grasshopper species can change color, behavior and form swarms at their high population densities and under certain environmental conditions (Forsman et al. 2002). A number of studies have been conducted at global, national, and regional levels to understand the diversity, distribution, and ecological roles of orthopteran.

Orthopterans, with 29,207 species globally, are the most abundant insects in terrestrial grassland ecosystems(Cigliano et al., 2024; Latchininsky et al., 2011; Guo et al., 2006; Jonas et al., 2007). They are also among the elements that significantly damage crops (Fartmann et al., 2021; Dakhel et al., 2020; Zhang et al., 2019). Several studies on the orthopteran fauna of India have been conducted. An inventory of India's Orthoptera was compiled by Shishodia et al., 2010. Caelifera and Ensifera are the two suborders of the order Orthoptera. Grouse locusts, locusts, and short-horned grasshoppers belong to the suborder Caelifera. In 2024, Sidharth et al. reported that the suborder Caelifera comprises 518 species, including Acrididae (285 species and 134 genera), Dericorythidae (4 species and 2 genera), Pamphagidae (1 species and 1 genus), Chorotypidae (9 species and 7 genera), Eumastacidae (8 species and 4 genera), Mastacideidae (8 species and 2 genera), Pyrgomorphidae (47 species and 21 genera), Tetrigidae (137 species and 39 genera), and Tridactylidae (19 species and 4 genera). Song (2018) reported that the Ensifera comprises two infraorders, Gryllidea and Tettigoniidea, distinguished by elongated, flagellate antennae frequently exceeding the body length, and a sword-like or needle-like female ovipositor. The Gryllidea encompass the superfamilies Grylloidea and Gryllotalpoidea, whereas the Tettigoniidea comprise the Schizodactyloidea, Rhaphidophoroidea, Hagloidea, Stenopelmatoidea, and Tettigonioidea.

Some members of the Orthoptera order have wings, while others are wingless (Maretta et al., 2025). Those with wings usually have four in total. The hind wings are broad, thin, and membranous, and are typically folded beneath the forewings when the insect is at rest. The forewings, which often feature many veins, can be elongated and have a firmer, leathery texture—these are called tegmina. The hind wings, in contrast, are delicate and filled with veins. A notable characteristic of Orthoptera is their enlarged hind legs, which are significantly longer than their middle legs (Maretta et al., 2025). These powerful legs are primarily used for jumping and, in some species, for producing sound. Additionally, certain Orthoptera can generate sound using their wings as well.

India, due to its extensive variety of climate zones and flora types, sustains a wide diversity of orthopterans. Chand et al. (2024) reported that the order Orthoptera has 29,434 species worldwide over 5,263 genera and 83 families, whereas in India, there are 1,274 species categorised under two suborders, belonging to 442 genera and 23 families. India is home to 698 indigenous species of Orthoptera. Tamil Nadu is represented by the highest number of species with 372, followed by West Bengal with 299, and Assam with 247. The areas with the least representation are Gujarat with 25 species, followed by Telangana with 19 species, and Ladakh with only 4 species (Chand et al., 2024). Bhaskar et al. (2019) and following studies by Chandra & Gupta (2022) identify numerous locations in India, such as the Western Ghats, Northeast Himalayas, and central plateau zones, as biodiversity hotspots for Orthoptera. The diversity of Indian orthopterans is frequently examined within agricultural entomology, as numerous species are recognised for inflicting damage on vital crops including rice, wheat, maize, and sugarcane. Recent research have concentrated on documenting species richness in natural settings, emphasising their ecological functions beyond agriculture. These studies underscore the necessity for conservation, particularly in forested and semi-arid regions where habitat degradation is prevalent.
Odisha, situated on India's eastern coast, features a distinctive amalgamation of coastal, woodland, and plateau environments that enhance its faunal diversity. Despite being relatively underexplored, the state has demonstrated encouraging records of orthopteran diversity. Kalahandi district, located in the western region of Odisha, serves as a transitional area between the Eastern Ghats and the central Indian plateau. It encompasses a blend of dense forests, agricultural terrain, and arid deciduous ecosystems, which provide appropriate habitats for numerous orthopteran species. Kalahandi, despite its biological richness, remains comparatively under-researched regarding entomofaunal variety. Recent field surveys and academic research endeavours have begun cataloguing orthopteranspecies in various settings, including forestland edges, agricultural areas, and grasslands. Researchers have observed seasonal variations in population density and species mix, correlating them with alterations in rainfall and temperature—characteristic features of grasshopper ecology. The absence of long-term data and comprehensive taxonomic investigations constrains our present comprehension of the complete richness in this region.

The examination of orthopteran diversity, covering global to local dimensions, emphasises the ecological significance of these insects and their importance for ongoing research. Despite substantial advancements globally and in numerous locations of India, areas like Odisha, especially districts such as Kalahandi, still demand comprehensive biodiversity evaluations. The ongoing local studies offer a basis for additional ecological, taxonomic, and conservation-oriented study. Comprehending orthopteran diversity in these lesser-known areas (like Kalahandi district of Odisha) is crucial for biodiversity documentation and vital for sustainable agricultural practices and ecosystem management.

**2. Material and Methods**

**2.1 Study Area**

The survey was conducted across various regions of the Kalahandi district between June 2024 and February 2025. We surveyed paddy fields, grasslands, forests, bushes, and open fields. Kalahandi district is located in the south-western part of the Indian state of Odisha. It lies between approximately 19°3′N to 20°3′N latitude and 82°20′E to 83°47′E longitude.

**2.2 Collections and identifications**

Orthopteran species were collected from different selected sites in Kalahandi district using insect collecting net and hand picking method. The study focused on the morphology and taxonomy of the species using a hand lens and comparative assessment of photographs. Photography was done using a Samsung A56 5G mobile with a 50 MP rear camera, photograph of all individuals are mentioned in the **Plate 1.** After observation, rare and live species were released back into their original habitats. Grasshopper identification was based on characters like color, size, wing pattern, and antennae using identification keys provided Kirby (1914) and Srinivasan (2013).

**2.3 Analysis**

We analyzed the data by calculating various indices to study the diversity and distribution of grasshoppers, by using following formulae. These included Simpson’s Index of Diversity (1-D), Shannon’s Diversity Index (H), and Pielou’s Evenness Index (J). Each index provided insights into species richness, abundance, and evenness across the study area.

**a. Simpson’s Index of Diversity (1-D)**

1−∑(Pi)2

where, Pi is the proportion of individuals found in the *i*th species.

 **b. Shannon’s Diversity Index (H)**

∑Pi, lnPi

 **c. Pielou’s Evenness Index (J)**

H/ln(S)

Where S is the total number of species.

**3. Results**

A total of 8,724 individual orthopteran were captured and identified, representing five different families. The family Acrididae had the highest species diversity, comprising 19 species across 15 genera. This was followed by the family Pyrgomorphidae, which included 7 species under 4 genera. The family Tettigoniidae consisted of 5 species across 4 genera. The lowest species diversity was recorded in the family Tetrigidae, with only a single species identified as mentioned in the **Table 1**.

In terms of individual counts, Atractomorphalata was the most abundant species, with 629 individuals recorded, followed by Acridaexaltata with 612 individuals. The species with the lowest number of individuals was Gryllodessigillatus, with just 9 captured (**Table 1**).

The Simpson’s Index of Diversity (1-D) was 0.961, suggesting high species diversity within the community. Additionally, Shannon’s Diversity Index (H) was 3.341, and Pielou’s Evenness Index (J) was 0.964, both reflecting a high level of species richness and an even distribution of individuals among species.

**Table 1. List of orthopteran species observed and recorded in the study**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl.No.** | **Family** | **Genus** | **Species** | **Common Name** | **Total Number of Individual** |
| 1. | Pyrgomorphidae | *Atractomorpha* | *lata* | Smallerlong-headed locust | 629 |
| *crenulata* | Tobacco grasshopper | 153 |
| *similis* | Northern grass pyrgomorph | 187 |
| *sinensis* | Pink-winged grasshopper | 136 |
| *Aularches* | *miliaris* | Spotted grasshopper | 51 |
| *Poekilocerus* | *pictus* | Indian painted grasshopper | 119 |
| *Tagasta* | *indica* | Gaudy or bush grasshopper | 238 |
| 2. | Acrididae | *Acrida* | *chinensis* | Chinese grasshopper | 272 |
| *cinerea* | Chinese grasshopper or Oriental longheaded grasshopper | 476 |
| *exaltata* | Oriental long headed grasshopper or short-horned grasshopper | 612 |
| *Gastrimargus* | *africanus* | Green locust | 153 |
| *musicus* | Yellow-winged locust | 221 |
| *Oxya* | *hyla* | Rice grasshopper or Spine-kneed grasshopper | 442 |
| *intricata* | Small rice grasshopper | 374 |
| *Bibracte* | *burmana* | Not known | 85 |
| *Cordillacris* | *crenulata* | Crenulated grasshopper or Crenulated winged grasshopper | 204 |
| *Cyrtacanthacris* | *tatarica* | Yellow-backed grasshopper | 391 |
| *Circotettix* | *maculatus* | Dancing grasshopper | 425 |
| *Diabolocatantops* | *pinguis* | Not known | 357 |
| *Dociostaurus* | *maroccanus* | Moroccan locust | 272 |
| *Kraussaria* | *angulifera* | Grasshopper pest of Pearl Millet | 306 |
| *Locusta* | *migratoria* | Baby green locust or Migratory locust | 255 |
| *Teratodes* | *monticollis* | Hooded grasshopper | 340 |
| *Trilophidia* | *japonica* | Japanese grasshopper | 221 |
| *Ochrilidia* | *geniculata* | Keeled grasshopper | 136 |
| *Xenocatantops* | *karnyi* | Not known | 323 |
| 3. | Tettigoniidae | *Conocephalus* | *maculatus* | Spotted meadow katydid | 187 |
| *melanus* | Black-kneed meadow katydid | 221 |
| *Mecopoda* | *elongata* | Tropical brown grasshopper | 357 |
| *Microcentrum* | *rhombifolium* | Broad-winged katydid | 136 |
| *Phaneroptera* | *falcata* | Sickle-bearing bush-cricket | 204 |
| 4. | Tetrigida | *Eucriotettix* | *hebard* | Pygmy grasshopper | 221 |
| 5. | Gryllidae | *Teleogryllus* | *derelictus* | Vietnamese field cricket | 11 |
| *Gryllodes* | *sigillatus* | Tropical house or Indian house or Banded cricket  | 09 |
| **Total** | **8724** |



**Plate 1 collected all Orthopteran species**; **D: Dorsal view; V: Ventral view**

*Bibracteburmana*(i-D, ii-V); *Aularches miliaris* (iii-D, iv-V); *Microcentrumrhombifolium*(v-D, vi-V); *Xenocatantopskarnyi*(vii-D, viii-V); *Mecopoda elongate* (ix-D, x-V); *Acridachinensis*(xi-D, xii-V); *Atractomorphasinensis*(xiii-D, xiv-V); *Gastrimargusmusicus*(xv-D, xvi-V); *Kraussariaangulifera*(xvii-D, xviii-V); *Cordillacriscrenulata*(xix-D, xx-L); *Diabolocatantopspinguis*(xxi-D, xxii-V); *Dociostaurusmaroccanus*(xxiii-D, xxiv-V); *Eucriotettixhebard*(xxv-D, xxvi-V); *Atractomorphasimilis*(xxvii-D, xxviii-V); *Locustamigratoria*(xxix-D, xxx-L); *Poekiloceruspictus*(xxxi-D, xxxii-L), *Acridaexaltata*(xxxiii-D, xxxiv-L); *Acridacinerea*(xxxv-D, xxxvi-V); *Cyrtacanthacristatarica*(xxxvii-D, xxxviii-L), *Teratodesmonticollis*(xxxix-D, xl-L); *Atractomorphacrenulata*(xli-D, xlii-L); *Gryllodessigillatus*(xliii-D, xliv-L); *Oxyahyla*(xlv-D); *Gastrimargus africanus* (xlvi-D); *Atractomorphalata*(xlvii-D); *Ochrilidiageniculata*(xlviii-D); *Tagastaindica*(xlix-D); *Oxya intricate* (l-D); *Conocephalusmelanus*(li-L); *Trilophidia japonica* (lii-L); *Conocephalus maculates* (liii-D); *Circotettix maculates* (liv-D); *Teleogryllusderelictus*(lv-D); *Phaneroptera falcate* (lvi-D)

**4. DISCUSSION**

In our study, the family Acrididae exhibited the highest number of species, with a total of 19 recorded. This observation aligns with global trends, as Acrididae is known to be the most species-rich family of orthopterans in various regions. For instance, ElEla et al. (2012) reported Acrididaeas the dominant family in Japan, and a similar pattern was observed in Kerala, India, where Sidharth et al. (2024) also documented the highest number of species belonging to this family. These findings suggest that Acrididae consistently demonstrates high diversity across different ecological zones and geographic locations.

Orthoptera is a highly diverse insect order found across the globe. Within this group, the suborder Caeliferawas observed in greater numbers compared to Ensifera in this particular study. This is likely because Caelifera species are active during the daytime, which aligned with the timing of the sample collection. Grasshoppers, which belong to Caelifera, begin their activity with the sunrise, as increased sunlight helps to stimulate their metabolism, encouraging both foraging behaviour and reproductive activities (Saupi et al., 2025). During warm, sunny days, these insects search for appropriate plant hosts to feed on. In contrast, Ensifera species are mainly active at night, engaging in feeding and mating behaviours under the cover of darkness (Tan et al., 2019). Since the fieldwork was limited to daytime hours, fewer Ensifera were recorded in the Kalahandi region of Odisha. To better understand the full range of Orthoptera present, future research should include both daytime and night time sampling to capture the activity of species with different circadian rhythms.

In studying the orthopteran population of a given area, several biodiversity indices were used to assess the structure and health of the community. These included Simpson’s Index of Diversity, Shannon’s Diversity Index, and Pielou’s Evenness Index. Together, these metrics provide a detailed picture of species richness (how many species are present), evenness (how equally the individuals are distributed among those species), and overall diversity.

When looking at the Simpson’s Index of Diversity, which is the complement of the Simpson’s Index (calculated as 1 - D), the result was 0.961. A higher value in this version of the index represents higher diversity, and a value of 0.961 is very close to 1, suggesting that the grasshopper community is actually very diverse, with many species coexisting and none dominating overwhelmingly. The presence of a diverse orthopteran community suggests a robust and healthy ecosystem, capable of supporting a wide range of species. This is likely due to a combination of habitat complexity, availability of resources, and overall environmental stability. However, such communities are increasingly facing threats. For instance, Gupta and Chandra (2016) reported a decline in orthopteran populations in the Barnawapara Wildlife Sanctuary, located in Chhattisgarh, India. Notably, Chhattisgarh shares a border with the Kalahandi district of Odisha, indicating that both regions experience similar ecological and climatic conditions. These areas are now witnessing the impacts of climate change and rapid urbanization, which are contributing to habitat degradation. Consequently, the orthopteran communities in Kalahandi may also be under growing pressure from these environmental changes, posing a risk to their long-term survival and biodiversity.

Adding further depth, the Shannon’s Diversity Index was calculated at 3.341, which also supports the idea of high biodiversity. This index takes into account both the number of species (richness) and how evenly the individuals are spread across those species (evenness). A value above 3 typically indicates that the community is both species-rich and well-balanced. In the case of the orthopteran population, a Shannon Diversity Index value of 3.341 indicates a highly complex and well-structured community, where species are relatively evenly distributed and no single species shows overwhelming dominance. This level of diversity is generally associated with healthy ecosystems that are capable of withstanding environmental changes and disturbances due to their ecological resilience.However, during our survey, we observed that the family Tetrigidae was represented by only a single species, making it the least represented family in our study. This trend is not uncommon, as similar findings have been reported in other regions. For example, Kočárek et al. (2011), Tumbrinck (2019), and Pushkar (2009) also documented a relatively low number of species belonging to the Tetrigidae family in their respective studies. The consistent observation of fewer Tetrigidae species across different geographical areas may point to their specific habitat requirements, lower population densities, or other ecological constraints.

Despite this, the overall species distribution and the high diversity indices observed in our study suggest a well-balanced orthopteran community, which is an encouraging indicator of ecosystem stability and biodiversity health in the region.

To assess how evenly species are distributed within the orthopteran community, we utilized Pielou’s Evenness Index, which yielded a value of 0.964. A value of 0.964 is considered very high and suggests that the species in the studied area are not only diverse in number—as confirmed by the high Shannon Diversity Index—but also well-represented in terms of population size. In other words, no single species dominates the community, and individuals are more or less evenly spread across different taxa. Such a high level of evenness is an important indicator of ecological balance and stability, often reflecting favorable environmental conditions and resource availability. Interestingly, similar patterns of species evenness have been reported in other biodiversity studies as well. For example, Stefanidis et al. (2023) and Mariottini et al. (2013) documented comparable findings in their surveys, further validating the significance of this metric in ecological assessments. These consistent results across different studies and regions highlight the value of Pielou’s Evenness Index in understanding the structural dynamics of biological communities.

Taken together, these indices paint a comprehensive picture of a highly diverse and well-balanced orthopteran community. The high values for both Shannon’s Index and Pielou’s Evenness indicate a stable and healthy ecosystem, while the Simpson’s Diversity Index confirms the same. Such conditions are often found in environments with varied microhabitats, diverse vegetation, and minimal human disturbance. A high species evenness value indicates that the individuals present within a habitat are distributed fairly equally among the different species, rather than being dominated by just a few. In the case of Kalahandi, the observed high species evenness among Orthoptera suggests a balanced ecological environment. This even distribution is likely influenced by the consistent availability of food resources across the study area. According to Maretta et al. (2025), food sources for Orthoptera—primarily vegetation—were spread uniformly across the various observation sites. This widespread and consistent distribution of food likely allowed multiple species to thrive without significant competition for resources, promoting a more balanced population structure. In such environments, the absence of resource monopolization by a dominant species encourages biodiversity and supports a stable ecosystem. Therefore, the high species evenness recorded in Kalahandi reflects both a healthy habitat and favorable conditions for a diverse range of Orthopteran species.

In conclusion, the orthopteran community being studied appears to be in excellent ecological condition. There is a rich variety of species, the population is well-balanced, and no single species is overly dominant. These conditions are typical of ecosystems that are functioning well and not under significant environmental stress. Maintaining such biodiversity is essential, as it supports ecological processes, increases resilience to change, and contributes to the overall health of the environment.

**5. CONCLUSION**

The analysis of orthopteran populations using key biodiversity indices—Simpson’s (0.961), Shannon’s (3.341), and Pielou’s Evenness (0.964)—indicates a highly diverse and well-balanced ecological community. These values reflect a healthy ecosystem with stable conditions that support rich species diversity and even distribution.

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**6. References**

1. Bhaskar, D., Easa, P. S., Sreejith, K. A., Skejo, J., &Hochkirch, A. (2019). Large scale burning for a threatened ungulate in a biodiversity hotspot is detrimental for grasshoppers (Orthoptera: Caelifera). *Biodiversity and conservation*, *28*(12), 3221-3237. <https://doi.org/10.1007/s10531-019-01816-6>
2. Chand, D. S., Das, S. K., Chakraborty, R., & Kumar, H. (2024). Checklist of Fauna of India: Arthropoda: Insecta: Orthoptera. *Version1. 0 Zoological Survey of India.* DOI: <https://doi.org/10.26515/Fauna/1/2023/>
3. Chandra, K., & Gupta, D. (2022). Biodiversity issues and challenges: non-agricultural insects. In *Biodiversity in india: status, issues and challenges* (pp. 285-324). Singapore: Springer Nature Singapore. <https://doi.org/10.1007/978-981-16-9777-7_13>
4. Chowdhury, S., Dubey, V. K., Choudhury, S., Das, A., Jeengar, D., Sujatha, B., ... & Kumar, V. (2023). Insects as bioindicator: A hidden gem for environmental monitoring. *Frontiers in Environmental Science*, *11*, 1146052.  <https://doi.org/10.3389/fenvs.2023.1146052>
5. Cigliano MM, Braun H, Eades DC, Otte D. Orthoptera Species File. Version 5.0/5.0. Available from: <http://Orthoptera.SpeciesFile.org> [Accessed 4th July 2024]
6. Dakhel WH, Jaronski ST, Schell S. Control of pest grasshoppers in North America. Insects. 2020;11:566. <https://doi.org/10.3390/insects11090566>
7. ElEla, S. A., ElSayed, W., & Nakamura, K. (2012). Incidence of orthopteran species (Insecta: Orthoptera) among different sampling sites within Satoyama area, Japan. *Journal of Threatened Taxa*, 2476-2480. <https://doi.org/10.11609/JoTT.o2775.2476-80>
8. Fartmann T, Poniatowski D, Holtmann L. Habitat availability and climate warming drive changes in the distribution of grassland grasshoppers. Agric. Ecosyst. Environ. 2021;320:107565. <https://doi.org/10.1016/j.agee.2021.107565>
9. Fartmann, T., Krämer, B., Stelzner, F., & Poniatowski, D. (2012). Orthoptera as ecological indicators for succession in steppe grassland. *Ecological Indicators*, *20*, 337-344. <https://doi.org/10.1016/j.ecolind.2012.03.002>
10. Forsman, A., Ringblom, K., Civantos, E., &Ahnesjo, J. (2002). Coevolution of color pattern and thermoregulatory behavior in polymorphic pygmy grasshoppers Tetrix undulata. *Evolution*, *56*(2), 349-360. <https://doi.org/10.1111/j.0014-3820.2002.tb01345.x>
11. Guo ZW, Li HC, Gan YL. Grasshopper (Orthoptera: Acrididae) biodiversity and grassland ecosystems. Insect Sci. 2006;13:221-227. [https://doi.org/10.1111/j.1744- 7917.2006.00086.x](https://doi.org/10.1111/j.1744-%207917.2006.00086.x)
12. Gupta, S. K., & Chandra, K. (2016). Orthoptera Fauna, it’s habitat ecology and threats in Barnawapara Wildlife Sanctuary, Chhattisgarh, India. *Ambient Science*, *3*(1), 29-37. DOI:10.21276/ambi.2016.03.1.ra04
13. Jonas JL, Joern A. Grasshopper (Orthoptera: Acrididae) communities respond to fire, bison grazing and weather in North American tallgrass prairie: a long-term study. Oecologia. 2007;153:699-711. <https://doi.org/10.1007/s00442-007-0761-8>
14. Kirby W.F. (1914). The Fauna of British India, including Ceylon and Burma. Orthoptera (Acrididae). London;
15. Kočárek, P., Holuša, J., Grucmanová, Š., & Musiolek, D. (2011). Biology of Tetrix bolivari (Orthoptera: Tetrigidae). *Open Life Sciences*, *6*(4), 531-544. <https://doi.org/10.2478/s11535-011-0023-y>
16. Latchininsky A, Sword G, Sergeev M, Cigliano MM, Lecoq M. Locusts & grasshoppers: behavior, ecology, and biogeography. Psyche. 2011;2011:578327. <https://doi.org/10.1155/2011/578327>
17. Maretta, G., Darmawan, A., Sari, D. A., & Mulyana, J. S. (2025). Diversity of the Orthoptera at the Institut Teknologi Sumatera. *Jurnal Inovasi Pendidikan dan Sains*, *6*(1), 23-28. <https://doi.org/10.51673/jips.v6i1.2438>
18. Mariottini, Y., De Wysiecki, M. L., & Lange, C. E. (2013). Diversity and distribution of grasshoppers (Orthoptera: Acridoidea) in grasslands of the Southern Pampas region, Argentina. *Revista de Biologia Tropical*, *61*(1), 111-124.
19. Pushkar, T. (2009). Tetrix tuerki (Orthoptera, Tetrigidae): distribution in Ukraine, ecological characteristic and features of biology. *Zoodiversity*, *43*(1), e-1. DOI 10.2478/v10058-009-0001-2
20. Saupi, N. A., Sulaiman, A., Hazmi, I. R., Nasir, D. M., DD, A., Abdullah, N. A., ... & Nor, W. N. A. W. M. (2025). Diversity of Orthoptera at Bukit Ulu Piah, Tambun, Perak, Peninsular Malaysia. *Malaysian Journal of Science*, 9-15. <http://adum.um.edu.my/index.php/MJS/article/view/43404>
21. Shishodia MS, Chandra K, Gupta SK. An annotated checklist of Orthoptera (Insecta) from India. Zoological Survey of India. 2010.
22. Sidharth, M., Jaleel, A., & Jayakrishnan, T. V. (2024). Diversity and distribution of grasshopper species in Kannur district, Kerala: A comprehensive survey. <https://doi.org/10.22271/j.ento.2024.v12.i4b.9358>
23. Song, H. (2018). Biodiversity of orthoptera. *Insect Biodivers Sci Soc*, *2*, 245-279.
24. Srinivasan, G. and Prabakar, D. (2013). A Pictorial Handbook on Grasshoppers of Western Himalayas: 1-75, (Published by the Director, ZoolSurv. India, Ko1kata).
25. Stefanidis, A., Zografou, K., Tzortzakaki, O., & Kati, V. (2023). Orthoptera Community Dynamics and Conservation in a Natura 2000 Site (Greece): The Role of Beta Diversity. *Diversity*, *16*(1), 11. <https://doi.org/10.3390/d16010011>
26. Tan, M. K., Japir, R., Chung, A. Y., & Robillard, T. (2019). Crickets of the subfamily Eneopterinae (Orthoptera: Grylloidea) from Sandakan, Sabah: one new species and calling songs of a sympatric species. *Zootaxa*, *4619*(2), 347-363. <https://dx.doi.org/10.11646/zootaxa.4619.2.9>
27. Tumbrinck, J. (2019). Taxonomic and biogeographic revision of the genus Lamellitettigodes (Orthoptera: Tetrigidae) with description of two new species and additional notes on Lamellitettix, Probolotettix, and Scelimena. *Journal of Orthoptera Research*, *28*(2), 167-180.
28. Zhang L, Lecoq M, Latchininsky A, Hunter D. Locust and grasshopper management. Annu Rev Entomol. 2019;64:15-34. <https://doi.org/10.1146/annurev-ento011118-112500>